National Aeronautics and Space Administration

SPACE COMMUNICATIONS AND NAVIGATION

ARTEMIS I

COMMUNICATIONS OVERVIEW

On our journey forward to the Moon and on to Mars, NASA must test our technologies and capabilities to ensure astronaut safety. The Artemis I mission will be an uncrewed flight test of the Orion spacecraft that places a human-rated crew vehicle in lunar orbit for the first time since the Apollo missions of the 1960s and 70s. The mission will showcase the capabilities of both Orion and the Space Launch System. NASA's powerful new rocket which will launch Artemis missions from Kennedy Space Center in Florida.

Communications services will allow flight controllers to send commands to the spacecraft and receive data from Orion and the Space Launch System. Artemis I will demonstrate NASA's networks' comprehensive communications services for journeys to lunar orbit. The mission relies on NASA's worldwide networked infrastructure for seamless communications, providing different service levels as Orion leaves Earth, orbits the Moon, and returns safely home.

ARTEMIS I NAVIGATION

Navigation services enable flight controllers to track where spacecraft are along their trajectory through space.

NASA's Near Space Network has three ground stations along Florida's space coast known as the Launch Communications Segment. These ground stations will track Artemis during launch and early phases of ascent. Additionally, the constellation of Tracking and Data Relay Satellites will provide tracking data that ensures the mission successfully ascends to orbit and returns to Earth.

On the journey to the Moon and in orbit around the Moon, the Deep Space Network's large ground antennas will provide primary tracking data. Near Space Network's ground stations in Chile and South Africa will supplement this tracking data. Using these stations, NASA will triangulate Orion's location using a technique called three-way Doppler tracking.

NETWORK SUPPORT FOR ARTEMIS I

NSN NEAR SPACE NETWORK

NASA's Near Space Network provides a comprehensive suite of communications and navigation services through commercial government-owned, contractor-operated network infrastructure. For Artemis I, the seamless support provided by the Near Space Network can be divided into two components: Direct-to-Earth (DTE) and Tracking and Data Relay Satellite (TDRS) services.

NSN DTE

Near Space Network DTE services are provided by a worldwide network of ground stations. These stations will provide communications and navigation services during launch and navigation services at various points on Artemis I's journey to the Moon.

NSN TDRS

The Near Space Network's TDRS constellation can provide near-continuous communications services to spacecraft near Earth. TDRS will play a critical role during launch and low-Earth orbit phases of the Artemis I mission as well as during reentry, splashdown, and recovery.

DSN DEEP SPACE NETWORK

The Deep Space Network will handle Artemis I communications beyond Near Space Network coverage, en route to and in orbit around the Moon. Additionally, the network will facilitate communications during the deployment of CubeSat payloads that will provide additional research opportunities for on Artemis I.

ARTEMIS I COMMUNICATIONS AND NAVIGATION MILESTONES

NSN DTE **NSN TDRS**

1 Launch

Both the Launch Communications Segment and the constellation of Tracking and Data Relay Satellites will maintain communication between the Space Launch System and Orion.

NSN TDRS

2 Low-Earth Orbit

In low-Earth orbit, NASA's Near Space Network TDRS will maintain continuous communications with Orion and the Interim Cryogenic Propulsion Stage (ICPS), which will accelerate Orion fast enough to overcome the pull of Earth's gravity and set it on a precise trajectory to the Moon.

NSN TDRS

3 ICPS Separation

Once Orion no longer needs the ICPS, the Near Space Network will monitor telemetry from the ICPS until it is out of range. The ICPS will continue towards the Moon on a heliocentric trajectory, deploying small satellites that provide additional science in translunar orbit.

NSN TDRS **DSN**

4 Handover to DSN

As Orion prepares to leave the area of near-Earth space covered by the Near Space Network, network engineers will pass communications services to the Deep Space Network.

DSN **NSN DTE**

5 Journey to the Moon

En route to the Moon, the Deep Space Network will be the primary method of communication with Earth, with Near Space Network ground stations providing supplementary tracking and navigation data.

DSN

6 Distant Retrograde Orbit

When Orion arrives at the Moon, it will enter a distant retrograde orbit, a highly stable orbit in which Orion travels opposite the direction the Moon travels around Earth. There, NASA will continue to test and demonstrate Orion's capabilities.

DSN **NSN DTE**

7 Return Transit

Returning from the Moon, the Deep Space Network will be the primary method of communication with Earth, with Near Space Network ground stations providing supplementary tracking and navigation data.

DSN **NSN TDRS**

8 Return Trajectory Correction Burn

During the final engine burn that places Orion on target to safely enter Earth's atmosphere, the Near Space Network will join the Deep Space Network, ultimately taking over communications for the remainder of the mission.

NSN TDRS

9 Re-entry

During re-entry, the enormous heat generated as Orion encounters the atmosphere turns the air surrounding the capsule into plasma. Until it dissipates, this can disrupt communications with the spacecraft.

NSN TDRS

10 Splashdown and Recovery

The Near Space Network maintains communications through the unfurling of parachutes, splashdown in the Pacific Ocean, and recovery of the capsule by military and NASA professionals.

SAR

SEARCH AND RESCUE

The Orion spacecraft is equipped with an emergency beacon designed by NASA's Search and Rescue office. Using Cospas-Sarsat, the international satellite-aided search and rescue network, this beacon will help NASA to quickly locate Orion upon activation of the beacon during splashdown or in the unlikely event of an abort scenario.

The Search and Rescue office has also developed specialized emergency beacons for Artemis astronauts returning from the Moon. Beginning with the Artemis II mission, These Advanced Next-Generation Emergency Locator (ANGEL) beacons will be placed on astronaut life vests. They will provide improved location accuracy should they need to egress from the capsule after splashdown or a launch abort.

These beacons use second-generation technology that improves on existing, publicly available distress beacons. NASA and the international search and rescue community have passed this second-generation technology to companies that will manufacture them for sale in the coming years.

ARTEMIS MISSION SUPPORT

NASA's Space Communications and Navigation (SCaN) program office provides strategic oversight and funding to NASA's networks and to the development of new communications and navigation technologies. SCaN will support all Artemis missions while providing astronauts with revolutionary communications capabilities.

Artemis II, the first crewed flight of Orion, will return astronauts to lunar orbit for the first time since the Apollo missions. The mission will include a SCaN-developed optical communications terminal that will use infrared lasers to enable live, 4K ultra-high-definition video from the Moon, as well as enhanced science data transmission and more.

LUNANET

SCaN is also developing LunaNet, a flexible lunar communications and navigation architecture that will play a key role in NASA's ambitious exploration initiatives under the Artemis program. LunaNet will allow NASA to extend internet-like service to the Moon, provide robust navigation data for lunar missions, and improve the situational awareness of astronauts establishing a sustainable presence off-world.